CHAPTER 16 (Odd)

1. a. $\mathbf{Z}_T = j6\ \Omega + 8\ \Omega\ \angle -90° \parallel 12\ \Omega\ \angle -90°$

$$= j6\ \Omega + \frac{(8\ \Omega\ \angle -90°)(12\ \Omega\ \angle -90°)}{-j8\Omega - j12\Omega} = j6\ \Omega + \frac{96\ \Omega\ \angle -180°}{20\ \angle -90°}$$

$$= j6\ \Omega + 4.8\ \Omega\ \angle -90° = j6\ \Omega - j4.8\ \Omega$$

$$\mathbf{Z}_T = j1.2\ \Omega = \mathbf{1.2\ \Omega\ \angle 90°}$$

b. $$\mathbf{I} = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{12\ \text{V}\ \angle 0°}{1.2\ \Omega\ \angle 90°} = \mathbf{10\ A\ \angle -90°}$$

c. $\mathbf{I}_1 = \mathbf{I} = \mathbf{10\ A\ \angle -90°}$

d. (CDR) $$\mathbf{I}_2 = \frac{(12\ \Omega\ \angle -90°)(10\ \text{A}\ \angle -90°)}{-j12\ \Omega - j8\Omega} = \frac{120\ \text{A}\ \angle -180°}{20\ \angle -90°} = \mathbf{6\ A\ \angle -90°}$$

$$\mathbf{I}_3 = \frac{(8\ \Omega\ \angle -90°)(10\ \text{A}\ \angle -90°)}{20\ \Omega\ \angle -90°} = \frac{80\ \text{A}\ \angle -180°}{20\ \angle -90°} = \mathbf{4\ A\ \angle -90°}$$

e. $\mathbf{V}_L = (I\ \angle \theta)(X_L\ \angle 90°) = (10\ \text{A}\ \angle -90°)(6\ \Omega\ \angle 90°) = \mathbf{60\ V\ \angle 0°}$

3. a. $\mathbf{Z}_T = 4.7\ \Omega \parallel (9.1\ \Omega - j12\ \Omega) = 4.7\ \Omega\ \angle 0° \parallel 15.06\ \Omega\ \angle -52.826°$

$$= \frac{70.782\ \Omega\ \angle -52.826°}{4.7 + 9.1 - j12} = \frac{70.782\ \Omega\ \angle -52.826°}{13.8 - j12}$$

$$= \frac{70.782\ \Omega\ \angle -52.826°}{18.288\ \angle -41.009°} = \mathbf{3.87\ \Omega\ \angle -11.817°}$$

$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_T} = \frac{1}{3.87\ \Omega\ \angle -11.817°} = \mathbf{0.258\ S\ \angle 11.817°}$$

b. $$\mathbf{I}_s = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{60\ \text{V}\ \angle 30°}{3.87\ \Omega\ \angle -11.817°} = \mathbf{15.504\ A\ \angle 41.871°}$$

c. (CDR) $$\mathbf{I}_2 = \frac{(4.7\ \Omega\ \angle 0°)(15.504\ \text{A}\ \angle 41.817°)}{4.7\ \Omega + 9.1\ \Omega - j12\ \Omega} = \frac{72.869\ \text{A}\ \angle 41.817°}{18.288\ \angle -41.009°}$$

$$= \mathbf{3.985\ A\ \angle 82.826°}$$

d. (VDR) $$\mathbf{V}_C = \frac{(12\ \Omega\ \angle -90°)(60\ \text{V}\ \angle 30°)}{9.1\ \Omega - j12\ \Omega} = \frac{720\ \text{V}\ \angle -60°}{15.06\ \angle -52.826°}$$

$$= \mathbf{47.809\ V\ \angle -7.174°}$$

e. $P = EI\cos\theta = (60\ \text{V})(15.504\ \text{A})\cos(41.87° - 30°)$

$$= 930.24(0.979) = \mathbf{910.71\ W}$$

5. a. $$400\ \Omega\ \angle -90° \parallel 400\ \Omega\ \angle -90° = \frac{400\ \Omega\ \angle -90°}{2} = 200\ \Omega\ \angle -90°$$

$\mathbf{Z}' = 200\ \Omega - j200\ \Omega = 282.843\ \Omega\ \angle -45°$

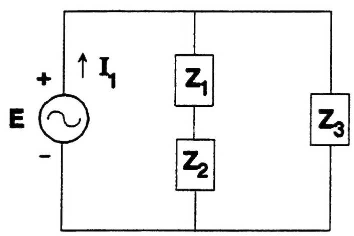
$\mathbf{Z}'' = 560\ \Omega + j560\ \Omega = 791.960\ \Omega\ \angle 45°$

$$Z_T = Z' \| Z'' = \frac{(282.843\ \Omega\ \angle -45°)(791.960\ \Omega\ \angle 45°)}{(200\ \Omega - j200\ \Omega) + (560\ \Omega + j560\ \Omega)}$$
$$= \frac{224{,}000.34\ \Omega\ \angle 0°}{840.952\ \angle 25.346°} = \mathbf{266.365\ \Omega\ \angle -25.346°}$$
$$I = \frac{E}{Z_T} = \frac{100\ V\ \angle 0°}{266.365\ \Omega\ \angle -25.346°} = \mathbf{0.375\ A\ \angle 25.346°}$$

b. $$V_C = \frac{(200\ \Omega\ \angle -90°)(100\ V\ \angle 0°)}{200\ \Omega - j200\ \Omega} = \frac{20{,}000\ V\ \angle -90°}{282.843\ \angle -45°} = \mathbf{70.711\ V\ \angle -45°}$$

c. $$P = EI\cos\theta = (100\ V)(0.375\ A)\cos 25.346°$$
$$= (37.5)(0.904) = \mathbf{33.9\ W}$$

7. a.



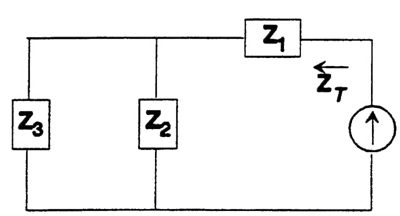
$$Z_1 = 10\ \Omega\ \angle 0°$$
$$Z_2 = 80\ \Omega\ \angle 90° \| 20\ \Omega\ \angle 0°$$
$$= \frac{1600\ \Omega\ \angle 90°}{20 + j80} = \frac{1600\ \Omega\ \angle 90°}{82.462\ \angle 75.964°}$$
$$= 19.403\ \Omega\ \angle 14.036°$$
$$Z_3 = 60\ \Omega\ \angle -90°$$

$$Z_T = (Z_1 + Z_2) \| Z_3$$
$$= (10\ \Omega + 18.824\ \Omega + j4.706\ \Omega) \| 60\ \Omega\ \angle -90°$$
$$= 29.206\ \Omega\ \angle 9.273° \| 6\Omega\ \angle -90° = \frac{1752.36\ \Omega\ \angle -80.727°}{28.824 + j4.706 - j60}$$
$$= \frac{1752.36\ \Omega\ \angle -80.727°}{62.356\ \angle -62.468°} = \mathbf{28.103\ \Omega\ \angle -18.259°}$$
$$I_1 = \frac{E}{Z_T} = \frac{40\ V\ \angle 0°}{28.103\ \Omega\ \angle -18.259°} = \mathbf{1.423\ A\ \angle 18.259°}$$

b. $$V_1 = \frac{Z_2 E}{Z_2 + Z_1} = \frac{(19.403\ \Omega\ \angle 14.036°)(40\ V\ \angle 0°)}{29.206\ \Omega\ \angle 9.273°} = \frac{776.12\ V\ \angle 14.036°}{29.206\ \angle 9.273°}$$
$$= \mathbf{26.574\ V\ \angle 4.763°}$$

c. $$P = EI\cos\theta = (40\ V)(1.423\ A)\cos 18.259°$$
$$= \mathbf{54.074\ W}$$

9. a.

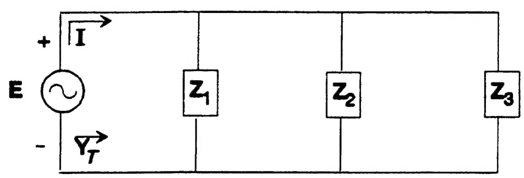


$$Z' = 3\ \Omega\ \angle 0° \| 4\ \Omega\ \angle -90° = \frac{12\ \Omega\ \angle -90°}{3 - j4}$$
$$= \frac{12\ \Omega\ \angle -90°}{5\ \angle -53.13°} = 2.4\ \Omega\ \angle -36.87°$$
$$Z_3 = 2\ Z' + j7\ \Omega$$
$$= 4.8\ \Omega\ \angle -36.87° + j7\ \Omega$$
$$= 3.84\ \Omega - j2.88\ \Omega + j7\ \Omega$$
$$= 3.84\ \Omega + j4.12\ \Omega$$
$$= 5.632\ \Omega\ \angle 47.015°$$

$$\mathbf{Z}_T = \mathbf{Z}_1 + \mathbf{Z}_2 \| \mathbf{Z}_3 = 6.8\ \Omega + 8.2\ \Omega\ \angle 0° \| 5.632\ \Omega\ \angle 47.015°$$
$$= 6.8\ \Omega + \frac{46.182\ \Omega\ \angle 47.015°}{8.2 + 3.84 + j4.12} = 6.8\ \Omega + \frac{46.182\ \Omega\ \angle 47.015°}{12.725\ \angle 18.891°}$$
$$= 6.8\ \Omega + 3.629\ \Omega\ \angle 28.124° = 6.8\ \Omega + 3.201\ \Omega + j1.711\ \Omega$$
$$= 10\ \Omega + j1.711\ \Omega = \mathbf{10.145\ \Omega\ \angle 9.709°}$$
$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_T} = \mathbf{0.099\ S\ \angle -9.709°}$$

b. $\mathbf{V}_1 = \mathbf{I}\mathbf{Z}_1 = (3\ \text{A}\ \angle 30°)(6.8\ \Omega\ \angle 0°) = \mathbf{20.4\ V\ \angle 30°}$
$\mathbf{V}_2 = \mathbf{I}(\mathbf{Z}_2 \| \mathbf{Z}_3) = (3\ \text{A}\ \angle 30°)(3.629\ \Omega\ \angle 28.124°)$
$= \mathbf{10.887\ V\ \angle 58.124°}$

c. $\mathbf{I}_3 = \dfrac{\mathbf{V}_2}{\mathbf{Z}_3} = \dfrac{10.877\ \text{V}\ \angle 58.124°}{5.632\ \Omega\ \angle 47.015°} = \mathbf{1.933\ A\ \angle 11.109°}$

11. 

$\mathbf{Z}_1 = 2\ \Omega - j2\ \Omega = 2.828\ \Omega\ \angle -45°$
$\mathbf{Z}_2 = 3\ \Omega - j9\ \Omega + j6\ \Omega$
$= 3\ \Omega - j3\ \Omega = 4.243\ \Omega\ \angle -45°$
$\mathbf{Z}_3 = 10\ \Omega\ \angle 0°$

$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \frac{1}{\mathbf{Z}_3} = \frac{1}{2.828\ \Omega\ \angle -45°} + \frac{1}{4.243\ \Omega\ \angle -45°} + \frac{1}{10\ \Omega\ \angle 0°}$$
$$= 0.354\ \text{S}\ \angle 45° + 0.236\ \text{S}\ \angle 45° + 0.1\ \text{S}\ \angle 0° = 0.59\ \text{S}\ \angle 45° + 0.1\ \text{S}\ \angle 0°$$
$$= 0.417\ \text{S} + j0.417\ \text{S} + 0.1\ \text{S}$$
$$\mathbf{Y}_T = 0.517\ \text{S} + j\,0.417\ \text{S} = \mathbf{0.664\ S\ \angle 38.889°}$$
$$\mathbf{Z}_T = \frac{1}{\mathbf{Y}_T} = \frac{1}{0.664\ \text{S}\ \angle 38.889°} = \mathbf{1.506\ \Omega\ \angle -38.889°}$$
$$\mathbf{I} = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{50\ \text{V}\ \angle 0°}{1.506\ \Omega\ \angle -38.889°} = \mathbf{33.201\ A\ \angle 38.889°}$$

13. $R_3 + R_4 = 2.7\ \text{k}\Omega + 4.3\ \text{k}\Omega = 7\ \text{k}\Omega$
$R' = 3\ \text{k}\Omega \| 7\ \text{k}\Omega = 2.1\ \text{k}\Omega$
$\mathbf{Z}' = 2.1\ \text{k}\Omega - j10\ \Omega$

(CDR) $\mathbf{I}'$ (of 10 Ω cap.) $= \dfrac{(40\ \text{k}\Omega\ \angle 0°)(20\ \text{mA}\ \angle 0°)}{40\ \text{k}\Omega + 2.1\ \text{k}\Omega - j10\ \Omega}$
$= 19\ \text{mA}\ \angle +0.014°$ as expected since $R_1 \gg \mathbf{Z}'$

(CDR) $\mathbf{I}_4 = \dfrac{(3\ \text{k}\Omega\ \angle 0°)(19\ \text{mA}\ \angle 0.014°)}{3\ \text{k}\Omega + 7\ \text{k}\Omega} = \dfrac{57\ \text{mA}\ \angle 0.014°}{10}$
$= 5.7\ \text{mA}\ \angle 0.014°$
$P = I^2R = (5.7\ \text{mA})^2\ 4.3\ \text{k}\Omega = \mathbf{139.71\ mW}$

CHAPTER 16 (Even)

2. a. $\mathbf{Z}_T = 3\ \Omega + j6\ \Omega + 2\ \Omega\ \angle 0° \parallel 8\ \Omega\ \angle -90°$
$= 3\ \Omega + j6\ \Omega + 1.94\ \Omega\ \angle -14.04°$
$= 3\ \Omega + j6\ \Omega + 1.882\ \Omega - j0.471\ \Omega$
$= 4.882\ \Omega + j5.529\ \Omega = \mathbf{7.376\ \Omega\ \angle 48.556°}$

b. $\mathbf{I}_s = \dfrac{\mathbf{E}}{\mathbf{Z}_T} = \dfrac{30\text{ V}\ \angle 0°}{7.376\ \Omega\ \angle 48.556°} = \mathbf{4.067\text{ A}\ \angle -48.556°}$

c. $\mathbf{I}_C = \dfrac{\mathbf{Z}_{R_2}\mathbf{I}_s}{\mathbf{Z}_{R_2} + \mathbf{Z}_C} = \dfrac{(2\ \Omega\ \angle 0°)(4.067\text{ A}\ \angle -48.556°)}{2\ \Omega - j8\ \Omega}$
$= \dfrac{8.134\text{ A}\ \angle -48.556°}{8.246\ \angle -75.964°} = \mathbf{0.986\text{ A}\ \angle 27.408°}$

d. $\mathbf{V}_L = \dfrac{\mathbf{Z}_L\mathbf{E}}{\mathbf{Z}_T} = \dfrac{(6\ \Omega\ \angle 90°)(30\text{ V}\ \angle 0°)}{7.376\ \Omega\ \angle 48.556°} = \dfrac{180\text{ V}\ \angle 90°}{7.376\ \angle 48.556°}$
$= \mathbf{24.403\text{ V}\ \angle 41.44°}$

4. a. $\mathbf{Z}_T = 2\ \Omega + \dfrac{(4\ \Omega\ \angle -90°)(6\Omega\ \angle 90°)}{-j4\ \Omega + j6\ \Omega} + \dfrac{4\ \Omega\ \angle 0°)(3\ \Omega\ \angle 90°)}{4\ \Omega + j3\ \Omega}$
$= 2\ \Omega + \dfrac{24\ \Omega\ \angle 0°}{2\ \angle 90°} + \dfrac{12\ \Omega\ \angle 90°}{5\ \angle 36.87°}$
$= 2\ \Omega + 12\ \Omega\ \angle -90° + 2.4\ \angle 53.13°$
$= 2\ \Omega - j12\ \Omega + 1.44\ \Omega + j1.92\ \Omega$
$= \mathbf{3.44\ \Omega - j10.08\ \Omega = 10.65\ \Omega\ \angle -71.16°}$

b. $\mathbf{V}_2 = \mathbf{I}(2.4\ \Omega\ \angle 53.13°) = (5\text{ A}\ \angle 0°)(2.4\ \Omega\ \angle 53.13°) = \mathbf{12\text{ V}\ \angle 53.13°}$
$\mathbf{I}_L = \dfrac{(4\ \Omega\ \angle 0°)(\mathbf{I})}{4\ \Omega + j3\ \Omega} = \dfrac{(4\ \Omega\ \angle 0°)(5\text{ A}\ \angle 0°)}{5\ \Omega\ \angle 36.87°} = \dfrac{20\text{ A}\ \angle 0°}{5\ \angle 36.87°} = \mathbf{4\text{ A}\ \angle -36.87°}$

c. $F_p = \dfrac{R}{Z_T} = \dfrac{3.44\ \Omega}{10.65\ \Omega} = \mathbf{0.323\ (leading)}$

6. a. $\mathbf{Z}_1 = 3\ \Omega + j4\ \Omega = 5\ \Omega\ \angle 53.13°$
$\mathbf{I}_1 = \dfrac{\mathbf{E}}{\mathbf{Z}_1} = \dfrac{120\text{ V}\ \angle 60°}{5\ \Omega\ \angle 53.13°} = \mathbf{24\text{ A}\ \angle 6.87°}$

b. $\mathbf{V}_C = \dfrac{(13\ \Omega\ \angle -90°)(120\text{ V}\ \angle 60°)}{-j13\ \Omega + j7\ \Omega} = \dfrac{1560\text{ V}\ \angle -30°}{6\ \angle -90°} = \mathbf{260\text{ V}\ \angle 60°}$

c. $\mathbf{V}_{R_1} = (I_1\ \angle\theta)R\ \angle 0° = (24\text{ A}\ \angle 6.87°)(3\ \Omega\ \angle 0°) = 72\text{ V}\ \angle 6.87°$
$\mathbf{V}_{\underset{+-}{ab}} + \mathbf{V}_{R_1} - \mathbf{V}_C = 0$
$\mathbf{V}_{\underset{+-}{ab}} = \mathbf{V}_C - \mathbf{V}_{R_1} = 260\text{ V}\ \angle 60° - 72\text{ V}\ \angle 6.87°$
$= (130\text{ V} + j225.167\text{ V}) - (71.483\text{ V} + j8.612\text{ V})$
$= \mathbf{58.517\text{ V} + j216.555\text{ V} = 224.32\text{ V}\ \angle 74.88°}$

8. a. $\mathbf{Z}_1 = 2\ \Omega + j1\ \Omega = 2.236\ \Omega\ \angle 26.565°, \mathbf{Z}_2 = 3\ \Omega\ \angle 0°$

$\mathbf{Z}_3 = 16\ \Omega + j15\ \Omega - j7\ \Omega = 16\ \Omega + j8\ \Omega = 17.889\ \Omega\ \angle 26.565°$

$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \frac{1}{\mathbf{Z}_3} = \frac{1}{2.236\ \Omega\ \angle 26.565°} + \frac{1}{3\ \Omega\ \angle 0°} + \frac{1}{17.889\ \Omega\ \angle 26.565°}$$
$$= 0.447\ \text{S}\ \angle -26.565° + 0.333\ \text{S}\ \angle 0° + 0.056\ \text{S}\ \angle -26.565°$$
$$= (0.4\ \text{S} - j0.2\ \text{S}) + (0.333\ \text{S}) + (0.05\ \text{S} - j0.025\ \text{S})$$
$$= 0.783\ \text{S} - j0.225\ \text{S} = \mathbf{0.815\ S\ \angle -16.032°}$$

$$\mathbf{Z}_T = \frac{1}{\mathbf{Y}_T} = \frac{1}{0.815\ \text{S}\ \angle -16.032°} = \mathbf{1.227\ \Omega\ \angle 16.032°}$$

b. $$\mathbf{I}_1 = \frac{\mathbf{E}}{\mathbf{Z}_1} = \frac{60\ \text{V}\ \angle 0°}{2.236\ \Omega\ \angle 26.565°} = \mathbf{26.834\ A\ \angle -26.565°}$$
$$\mathbf{I}_2 = \frac{\mathbf{E}}{\mathbf{Z}_2} = \frac{60\ \text{V}\ \angle 0°}{3\ \Omega\ \angle 0°} = 20\ \text{A}\ \angle 0°$$
$$\mathbf{I}_3 = \frac{\mathbf{E}}{\mathbf{Z}_3} = \frac{60\ \text{V}\ \angle 0°}{17.889\ \Omega\ \angle 26.565°} = \mathbf{3.354\ A\ \angle -26.565°}$$

c. $$\mathbf{I}_s = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{60\ \text{V}\ \angle 0°}{1.227\ \Omega\ \angle 16.032°} = \mathbf{48.9\ A\ \angle -16.032°}$$

$$\mathbf{I}_s \stackrel{?}{=} \mathbf{I}_1 + \mathbf{I}_2 + \mathbf{I}_3$$

$$48.9\ \text{A}\ \angle -16.032° \stackrel{?}{=} 26.834\ \text{A}\ \angle -26.565° + 20\ \text{A}\ \angle 0° + 3.354\ \text{A}\ \angle -26.565°$$
$$= (24\ \text{A} - j12\ \text{A}) + (20\ \text{A}) + (3\ \text{A} - j1.5\ \text{A})$$
$$\stackrel{\checkmark}{=} 47\ \text{A} + j13.5\ \text{A} = \mathbf{48.9\ A\ \angle -16.026°}\ \text{(checks)}$$

d. $$F_p = \frac{G}{Y_T} = \frac{0.783\ \text{A}}{0.815\ \text{S}} = \mathbf{0.961\ (lagging)}$$

10. a. $X_{L_1} = \omega L_1 = 2\pi(10^3\ \text{Hz})(0.1\ \text{H}) = 628\ \Omega$

$X_{L_2} = \omega L_2 = 2\pi(10^3\ \text{Hz})(0.2\ \text{H}) = 1.256\ \text{k}\Omega$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi(10^3\ \text{Hz})(1\ \mu\text{F})} = 0.159\ \text{k}\Omega$$
$$\mathbf{Z}_T = R\ \angle 0° + X_{L_1}\ \angle 90° + X_C\ \angle -90° \,\|\, X_{L_2}\ \angle 90°$$
$$= 300\ \Omega + j628\ \Omega + 0.159\ \text{k}\Omega\ \angle -90° \,\|\, 1.256\ \text{k}\Omega\ \angle 90°$$
$$= 300\ \Omega + j628\ \Omega - j182\ \Omega$$
$$= \mathbf{300\ \Omega + j446\ \Omega = 537.51\ \Omega\ \angle 56.07°}$$
$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_T} = \frac{1}{537.51\ \Omega\ \angle 56.07°} = \mathbf{1.86\ mS\ \angle -56.07°}$$

b. $$\mathbf{I}_s = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{50\ \text{V}\ \angle 0°}{537.51\ \Omega\ \angle 56.07°} = \mathbf{93\ mA\ \angle -56.07°}$$

c. (CDR): $\mathbf{I}_1 = \dfrac{\mathbf{Z}_{L_2}\mathbf{I}_s}{\mathbf{Z}_{L_2} + \mathbf{Z}_C} = \dfrac{(1.256\text{ k}\Omega\ \angle 90°)(93\text{ mA}\ \angle -56.07°)}{+j1.256\text{ k}\Omega - j0.159\text{ k}\Omega}$

$= \dfrac{116.81\text{ mA}\ \angle 33.93°}{1.097\ \angle 90°} = \mathbf{106.48\ mA\ \angle -56.07°}$

$\mathbf{I}_2 = \dfrac{\mathbf{Z}_C\mathbf{I}_s}{\mathbf{Z}_{L_2} + \mathbf{Z}_C} = \dfrac{(0.159\text{ k}\Omega\ \angle -90°)(93\text{ mA}\ \angle -56.07°)}{1.097\text{ k}\Omega\ \angle 90°}$

$= \dfrac{14.79\text{ mA}\ \angle -146.07°}{1.097\ \angle 90°} = 13.48\text{ mA}\ \angle -236.07°$

$= \mathbf{13.48\ mA\ \angle 123.93°}$

d. $\mathbf{V}_1 = (I_2\ \angle\theta)(X_{L_2}\ \angle 90°) = (13.48\text{ mA}\ \angle 123.92°)(1.256\text{ k}\Omega\ \angle 90°)$

$= \mathbf{16.931\ V\ \angle 213.93°}$

$V_{\underset{+-}{ab}} = \mathbf{E} - (I_s\ \angle\theta)(R\ \angle 0°) = 50\text{ V}\ \angle 0° - (93\text{ mA}\ \angle -56.07°)(300\ \Omega\ \angle 0°)$

$= 50\text{ V} - 27.9\text{ V}\ \angle -56.07°$

$= 50\text{ V} - (15.573\text{ V} - j23.149\text{ V})$

$= 34.43\text{ V} + j23.149\text{ V} = \mathbf{41.49\ V\ \angle 33.92°}$

e. $P = I_s^2 R = (93\text{ mA})^2 300\ \Omega = \mathbf{2.595\ W}$

f. $F_p = \dfrac{R}{Z_T} = \dfrac{300\ \Omega}{537.51\ \Omega} = \mathbf{0.558\ (lagging)}$

12. $\mathbf{Z}' = 12\ \Omega - j20\ \Omega = 23.324\ \Omega\ \angle -59.036°$

$R_4\ \angle 0° \| \mathbf{Z}' = 20\ \Omega\ \angle 0° \| 23.324\ \Omega\ \angle -59.036° = 12.362\ \Omega\ \angle -27.031°$

$Z'' = R_3\ \angle 0° + R_4\ \angle 0° \| \mathbf{Z}' = 12\ \Omega + 12.362\ \Omega\ \angle -27.031°$

$= 12\ \Omega + (11.012\ \Omega - j5.618\ \Omega)$

$= 23.012\ \Omega - j5.618\ \Omega = 23.688\ \Omega\ \angle -13.719°$

$R_2\ \angle 0° \| \mathbf{Z}'' = 20\ \Omega\ \angle 0° \| 23.688\ \Omega\ \angle -13.719° = 10.922\ \Omega\ \angle -6.277°$

$\mathbf{Z}_T = R_1\ \angle 0° + R_2\ \angle 0° \| \mathbf{Z}'' = 12\ \Omega + 10.922\ \Omega\ \angle -6.277°$

$= 12\ \Omega + (10.857\ \Omega - j1.194\ \Omega)$

$= 22.857\ \Omega - j1.194\ \Omega = \mathbf{22.888\ \Omega\ \angle -2.99°}$

$\mathbf{I}_s = \dfrac{\mathbf{E}}{\mathbf{Z}_T} = \dfrac{100\text{ V}\ \angle 0°}{22.888\ \Omega\ \angle -2.99°} = \mathbf{4.371\ A\ \angle 2.99°}$

$\mathbf{I}_{R_1} = \mathbf{I}$

$\mathbf{I}_{R_3} = \dfrac{R_2\ \angle 0° \mathbf{I}_s}{R_2\ \angle 0° + \mathbf{Z}''} = \dfrac{(20\ \Omega\ \angle 0°)(4.371\text{ A}\ \angle 2.99°)}{\underbrace{20\ \Omega + 23.012\ \Omega}_{43.012\ \Omega} - j5.618\ \Omega} = \dfrac{87.42\text{ A}\ \angle 2.99°}{43.377\ \angle -7.442°}$

$= \mathbf{2.015\ A\ \angle 10.432°}$

$\mathbf{I}_5 = \dfrac{R_4\ \angle 0° \mathbf{I}_{R_3}}{R_4\ \angle 0° + \mathbf{Z}'} = \dfrac{(20\ \Omega\ \angle 0°)(2.015\text{ A}\ \angle 10.432°)}{\underbrace{20\ \Omega + 12\ \Omega}_{32\ \Omega} - j20\ \Omega} = \dfrac{40.3\text{ A}\ \angle 10.432°}{37.736\ \angle -32.005°}$

$= \mathbf{1.068\ A\ \angle 42.437°}$

14. $\mathbf{Z}' = X_{C_2} \angle -90° \| R_1 \angle 0° = 2\ \Omega \angle -90° \| 1\ \Omega \angle 0°$

$$= \frac{2\ \Omega \angle -90°}{1 - j2} = \frac{2\ \Omega \angle -90°}{2.236 \angle -63.435°}$$

$= 0.894\ \Omega \angle -26.565°$

$\mathbf{Z}'' = X_{L_2} \angle 90° + \mathbf{Z}' = +j8\ \Omega + 0.894\ \Omega \angle -26.565°$

$= +j8\ \Omega + (0.8\ \Omega - j4\ \Omega)$

$= 0.8\ \Omega + j4 = 4.079\ \Omega \angle 78.69°$

$$\mathbf{I}_{X_{L_2}} = \frac{X_{C_1} \angle -90° \mathbf{I}}{X_{C_1} \angle -90° + \mathbf{Z}''} = \frac{2\ \Omega(\angle -90°)(0.5\ \text{A} \angle 0°)}{-j2\ \Omega + (0.8\ \Omega + j4\ \Omega)} = \frac{1\text{A} \angle -90°}{0.8 + j2}$$

$$= \frac{1\ \text{A} \angle -90°}{2.154 \angle 68.199°} = 0.464\ \text{A} \angle -158.99°$$

$$\mathbf{I}_1 = \frac{X_{C_2} \angle -90° \mathbf{I}_{X_{L_2}}}{X_{C_2} \angle -90° + R_1} = \frac{(2\ \Omega \angle -90°)(0.464\ \text{A} \angle -158.99°)}{-j2\ \Omega + 1\ \Omega} = \frac{0.928\ \text{A} \angle -248.99°}{2.236 \angle -63.435°}$$

$= \mathbf{0.415\ A \angle 174.45°}$